

SAMPLE RETURN MISSIONS WHERE CONTAMINATION ISSUES ARE CRITICAL: GENESIS

MISSION APPROACH. J. H. Allton¹ and E. K. Stansbery¹. Mail Code KT, NASA/Johnson Space Center, Houston, TX 77058, USA, Judith.h.allton@nasa.gov.

Introduction: The Genesis Mission, sought the challenging analytical goals of accurately and precisely measuring the elemental and isotopic composition of the Sun to levels useful for planetary science, requiring sensitivities of ppm to ppt in the outer 100 nm of collector materials [1]. Analytical capabilities were further challenged when the hard landing in 2004 broke open the canister containing the super-clean collectors. Genesis illustrates that returned samples allow flexibility and creativity to recover from setbacks.

Long-term Teamwork: Engineering, Science & Curation: In addition to the management and engineering teams that design, build and fly the spacecraft, this sample return mission has a science analysis team and a sample curation team that were fully engaged from the initial planning, through spacecraft design, spaceflight, Earth recovery and continuing through curation of samples today. The Principal Investigator continues to encourage collaborative efforts and is hands-on with details. Early, the science team was involved in choosing, fabricating and certifying the purity and cleanliness of the collector materials. To measure specific objectives, a variety of collector types were selected, providing alternate means to achieve the same goal. From the beginning, the curation team was responsible for contamination control, and participated in mission design (to minimize effects of thrusters and spacecraft offgassing upon the cleanliness of the solar collectors during flight), and reviewed collector design and fabrication techniques to minimize contaminants.

Collector Materials: Cleanliness and Variety. The Genesis approach was to start with clean collectors and keep them clean; thus, all handling of collectors after cleaning was performed in ISO Class 4 (Fig. 1). The variety of materials selected for each type of analysis [2] also allowed a variety of post-mission cleaning techniques to be applied. In addition to bulk solar wind composition, collectors were deployed to sample specific regimes of the solar wind. These regime collectors were not only identified by position in the spacecraft, but by thickness of collector – which, due to the canister breakup, is now essential for identifying solar regime.

Super-clean Science Canister Assembly: Keeping the solar wind collectors clean was accomplished by cleaning and assembling the collector canister in an ISO Class 4 cleanroom (Class 10 by Fed. Std. 209E) at Johnson Space Center curation facilities. Cleaning of canister hardware, to particle level 50 (MIL-STD-1246C) or better, was done with ultrapure water, to

avoid traces of cleaning fluid residues. Airborne molecular contamination levels during assembly were measured on polished witness plates at 10 ng/cm². Canister design isolated the lubricants from collector environment. The canister was sealed under ISO Class 4 and not opened until collection at Earth-Sun L1 began.

Reference Materials: Reference materials from collectors, spacecraft hardware and cleanroom were archived and proved critical for assessing blanks when measuring solar wind.

Summary: Science and curation teams participated in the mission planning from the very beginning, giving input on science cleanliness and contamination control requirements for all aspects of the mission. For many specific analytical objectives, a variety of collector types were designated, which allowed redundancy, multiple analytical techniques and multiple approaches to cleaning the collectors. All of which were especially useful after the hard landing. The collectors were isolated within a canister which was cleaned and sealed entirely under ISO Class 4 conditions.

References: [1] Burnett D. S. *et al.* (2003) *Space Sci. Rev.*,105, 509-534. [2] Jurewicz A. J. G. *et al.* (2003) *Space Sci. Rev.*,105, 553-560. [3] Allton J. H. *et al.* (2002) JSC-29742.



Fig. 1. Assembly of Genesis collectors in ISO Class 4 cleanroom at Johnson Space Center. Workers are enclosed in Teflon suits with HEPA-filtered exhaust.